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THE ROLE OF ANTI-SOLAR PROTECTION IN THE REDUCTION OF SOLAR GAINS IN THE PASSIVE SPORTS HALL

ROLA OSŁON PRZECIWSŁONECZNYCH W OGRANICZENIU ZYSKÓW SOLARNYCH W PASYWNEJ HALI SPORTOWEJ

A b s t r a c t

In this paper, the influence of anti-solar protection on the reduction of solar gains in a public building was analysed. Indoor thermal conditions in the building were verified by way of computer simulations for two scenarios: without any protection against solar gains and with the application of blinds and overhangs.

Keywords: *passive building*, *anti-solar protection*

S t r e s z c z e n i e

W artykule przeanalizowano wpływ osłon przeciwsłonecznych na ograniczenie zysków solarnych w pasywnym budynku użyteczności publicznej. Dokonano porównania warunków wewnętrznych w badanym obiekcie bez zabezpieczeń przed zyskami solarnymi oraz z zastosowaniem rolet i łamaczy światła.

Słowa kluczowe: *budynek pasywny*, *osłony przeciwsłoneczne*

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1. Introduction

The necessity of reducing solar gain in periods of high air temperatures in the context of passive buildings, results in the formation of special structural solutions. Technical requirements on glass partitions have been specified by the Regulation of the Ministry of Infrastructure concerning the buildings and their locations [1]. In the summer, overheated rooms may cause unreasonable economical and operating problems. Thus, anti-solar protection is used. It plays an important role in creating advantageous indoor environmental conditions as well as positively affecting the energy efficiency of the building.

Systems of anti-solar protection, as a necessary part of glazed surfaces, have to determine the amount of the sunlight getting into the building. This control over the sunlight itself, and the amount of thermal energy it introduces to the internal environment, is accomplished by way of such devices as window blinds and overhangs. They can be situated both outside and inside the building. Their location, dimensions and the slope determines the effectiveness of their ability to deal with the radiation [2].

In case of the analysed sports hall building, there were horizontal stationary large size blinds (so-called “overhangs”) mounted on the south elevation. Aluminium screens prevent sunlight penetrating into the building when the sun is high. However, stationary overhangs do not adjust to the current light needs. Thus, additional indoor blinds were used. This popular solution reduces the exposure to the sunlight and visual contact with the outside environment.

2. Input assumptions for the Design Builder software analyses

Thermal analyses were performed using the Design Builder software, which is the GUI (Graphical User Interface) of the computational software Energy Plus. The latter was created on the request of the government of the USA.

Geometry data of the analysed sports hall building was thoroughly represented in the context of its shape, dimensions and the location of the windows. A geometric model of the building created using the Design Builder software is presented in the Fig. 1.

The above mentioned model enabled an analysis of the real structure in terms of its thermal behaviour. Characteristics of both transparent and opaque walls, infiltration of the air from outside, internal heat sources’ gains as well as the presence of various installations were taken into account in the utilized program.

In accordance with the design assumptions, 1m long overhangs were modelled in a program.

Simulations were performed the for time period with the highest air temperature, i.e. from the 1st of May to the 30th of August. Four simulation cases with different versions of the south elevation equipment were considered:

– Basic – with no overhangs nor window blinds,
– With overhangs but without window blinds,
– Without overhangs but with window blinds,
– With both overhangs and window blinds.

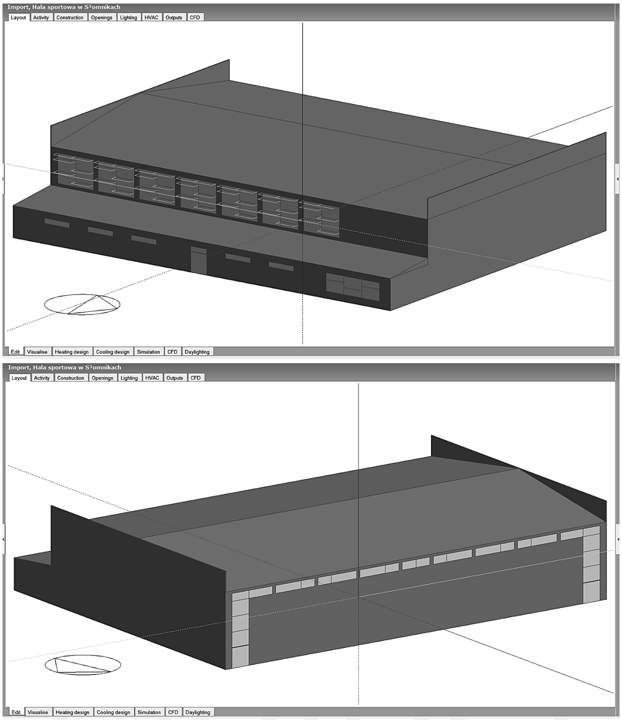

Fig. 1. South and north elevation of the sports hall building

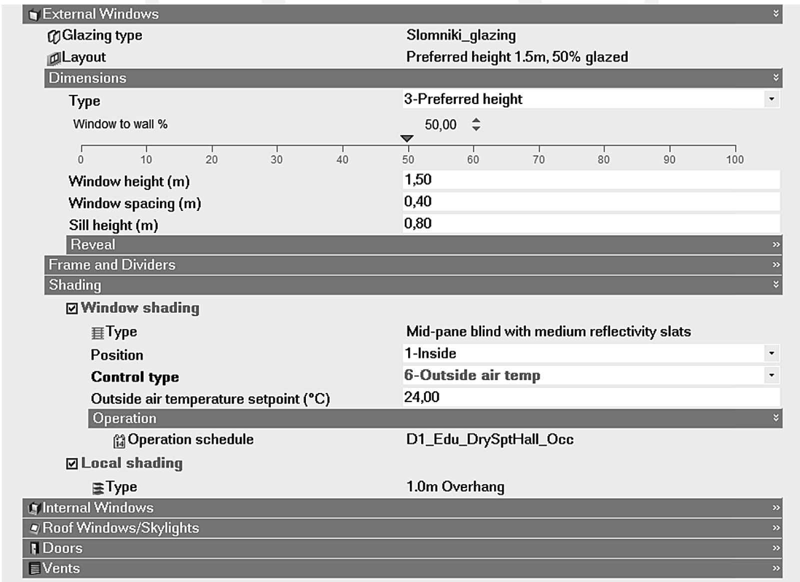

Fig. 2. Foundations received in modelling

3. Numerical results

On the basis of the performed numerical simulations, one can formulate conclusions concerning the effectiveness of the applied anti-overheating solutions and also evaluate their impact on the microclimate conditions inside the sports hall passive building *n* the period of high outdoor air temperatures.

A building with no anti-solar protection generates approximate energy gains of 117.73 kWh per day within the whole analysis period. The maximum daily gain was equal to 187.24 kWh. The lowest values of the undesired solar energy (in summer) were calculated in case of overhangs and the application of internal window blinds. They were equal to approximately 79,25 kWh.

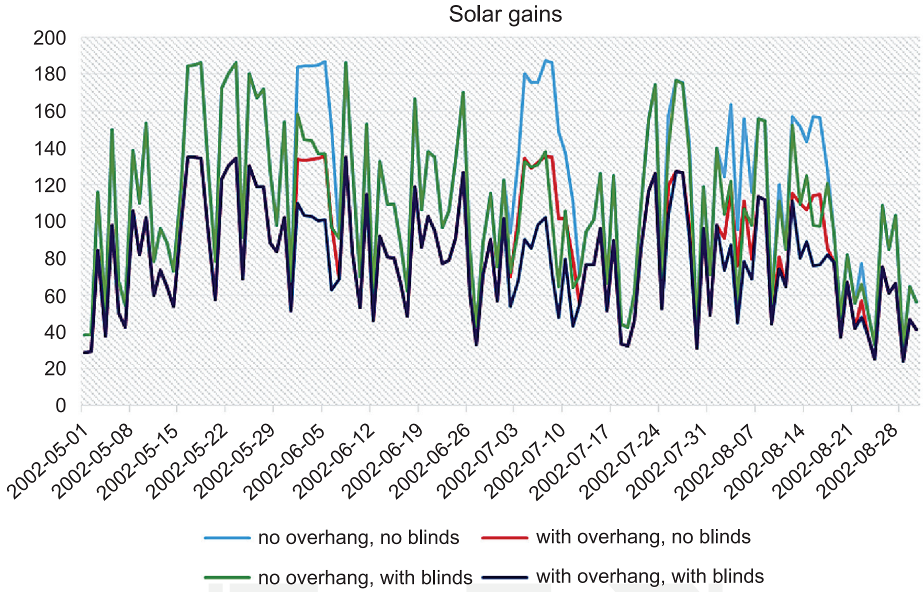

Fig. 3. Solar gains through external windows for four simulation cases

Table 1

Min, max and medium values for all simulations

[kWh]	no overhang no blind	with overhang no blind	no overhang with blind	with overhang with blind
Min	31.66	24.03	31.66	24.03
Max	187.24	135.55	186.19	135.12
Medium	117.73	108.23	108.23	79.25

The air temperature inside the building reaches the maximum (equal to 27.28°C) in the case of the application of window blinds (without external overhangs). The average air temperatures are also the highest in the above case. The lowest air temperature inside the building was calculated in the case of the application of overhangs with no blinds. However, it should be pointed out that solar gains are larger than for the case that is marked with navy blue in Fig. 3.

Table 2

Min, max and medium air temperature

[°C]	no overhang no blind	with overhang no blind	no overhang with blind	with overhang with blind
Min	15.09	15.07	15.09	15.07
Max	26.20	25.68	27.28	26.87
Medium	20.44	20.07	20.64	20.29

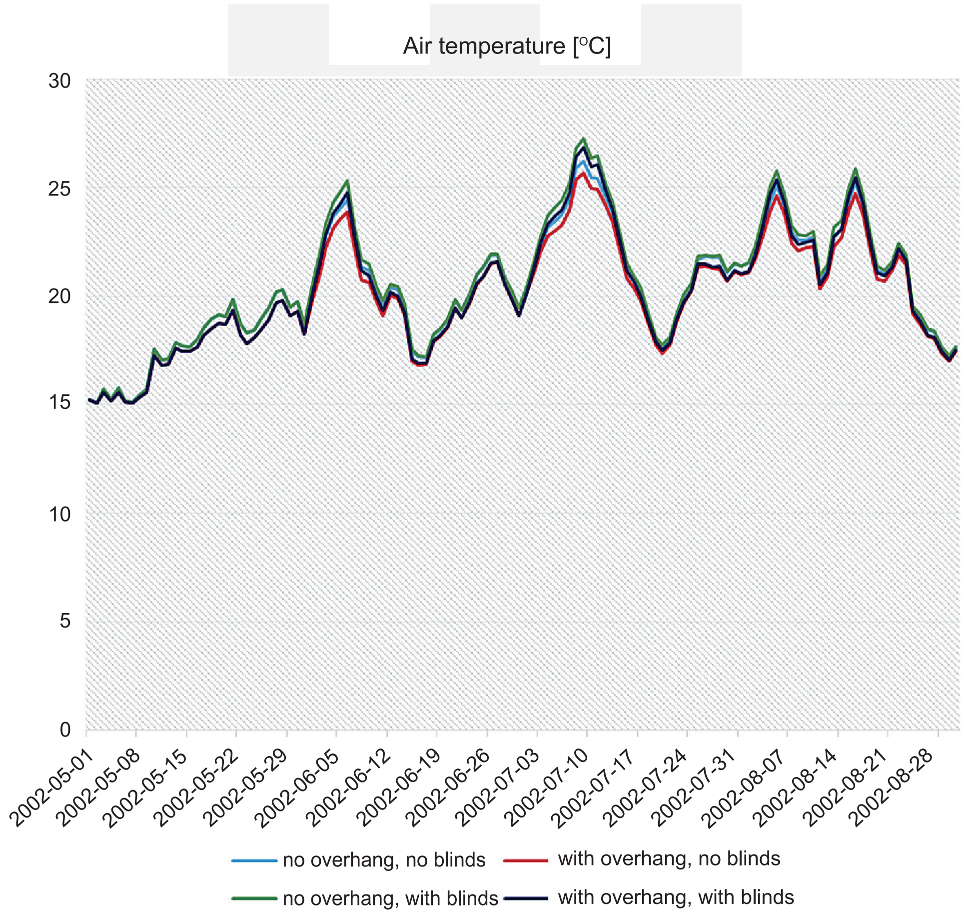

Fig. 4. Indoor air temperature for four simulation cases

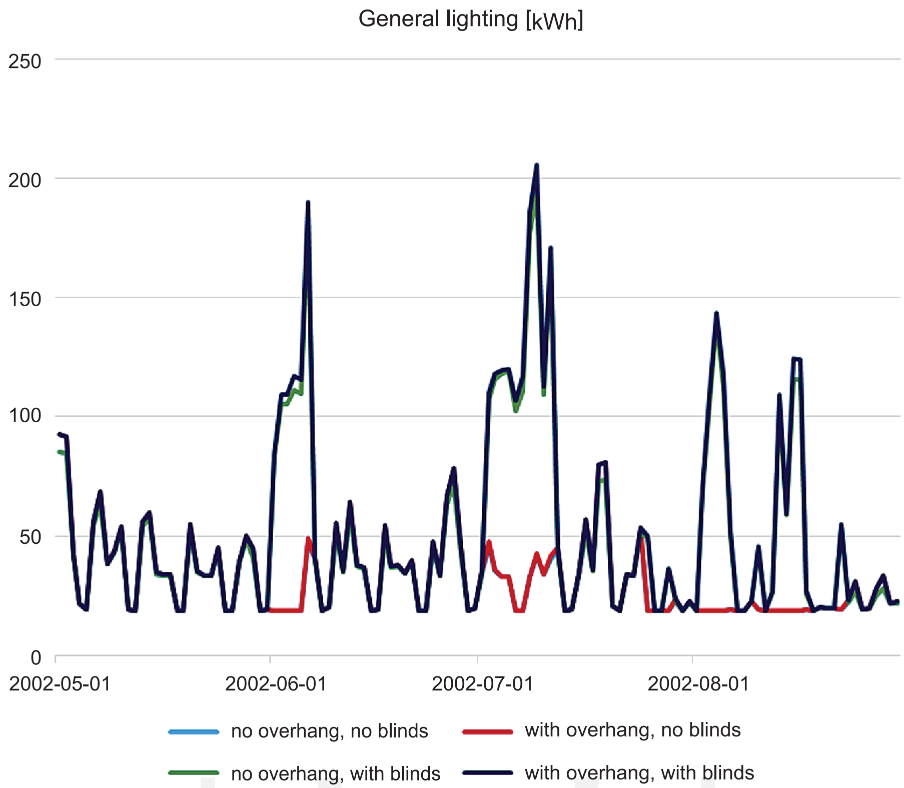

Fig. 5. General lighting for four simulation cases

Table 3

General lighting

[kWh]	no overhang no blind	with overhang no blind	no overhang with blind	with overhang with blind
Min	18.75	18.75	18.75	18.75
Max	85.47	92.78	193.74	205.72
Medium	31.32	32.28	50.69	52.60

In both cases with no internal window blinds, the energy used for lighting was the lowest. The largest lighting demand can be observed for the fourth variant (with internal window blinds and external overhangs), when the artificial lighting consumes the energy of 52.60 kWh.

4. Conclusions

Periods of high external air temperatures and strong sunlight are very difficult in the context of maintaining good conditions inside passive buildings. Exposure to sunlight of buildings with walls made mostly of glass may result into their overheating. Thus, application of anti-solar protection is necessary in order to reduce excessive solar gains.

According to the performed analyses, the most effective method of solar gain reduction is using both window blinds and overhangs during periods of the most intensive sunlight. In such a case, solar gains are approximately 30% lower compared to windows without anti-solar protection and they are equal to 79.25 kWh per day. However, it should be remarked that more energy is necessary for lighting purposes. It results in the generation of additional thermal gains inside the sports hall building. The total energy demand in this case is equal to 131.86 kWh and the maximum air temperature equals 26.87°C. The worst situation steps out in variant third (without overhangs but with internal window blinds) where solar gains are equal to 158.93 kWh and the maximum air temperature equals 27.28°C.

The most effective strategy from an economic point of view (regarding indoor environmental conditions) is the application of both overhangs and blinds. They reduce sunlight to a full extent. Internal roller blinds increase the demand on lighting by about 70%, but total gains are the lowest when he joins them with overhangs I don’t know what you mean with this last phrase, it needs rewriting.

References

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